Effects of Spin-Isospin Modes in Transport Simulations*

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Collisions between heavy nuclei at intermediate energies produce hot and dense hadronic matter that may be probed by means of the energetic particles emitted. The dynamics of nuclear collisions at intermediate energies can be fairly well understood within microscopic transport models, in which the hadrons are propagated in an effective one-body field while subject to direct elastic and inelastic two-body collisions. In particular, sufficiently energetic NN collisions may agitate one or both of the collision partners to a nucleon resonance. Such resonances propagate in their own mean field and may collide with nucleons or other nucleon resonances as well. Furthermore, the nucleon resonances may decay by meson emission and these decay processes constitute the main mechanisms for the production of energetic mesons.

Normally, the transport descriptions employ the vacuum properties of the baryon resonances and mesons, *i.e.* cross sections, decay widths, and dispersion relations are taken as their values in vacuum. However, the strong interaction between pions, nucleons, and Δ isobars may generate spin-isospin modes in nuclear matter. While most of these modes are non-collective in character, being dominated by a single baryon-hole excitation, others are collective and correspond to meson-like states (quasi-mesons) that may be important in the transport description.

To gain a qualitative impression of whether the in-medium properties in idealized nuclear matter survive the transport simulations, we have incorporated in-medium properties derived for nuclear matter in a microscopic $\pi + NN^{-1} + \Delta N^{-1}$ model [1] into transport simulations of nuclear collisions by means of a local-density approximation and by utilizing a local medium frame.

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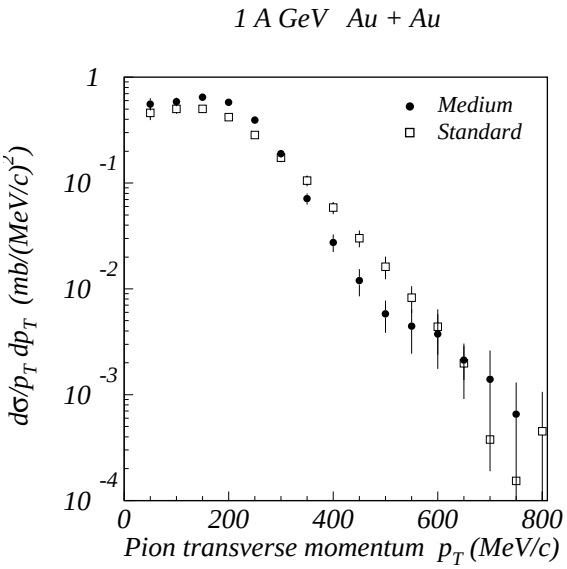

Figure 1: Transverse momentum spectrum for neutral pions having $|y_{\rm cm}| < 0.16$. Solid circles represents simulations with medium properties included, while open squares correspond to the standard BUU simulations.

We have performed simulations with and without the in-medium modifications for central collisions of two different symmetric systems, one light, ^{40}Ca+^{40}Ca, and one heavy ^{197}Au+^{197}Au, each at two different energies, 500 and 1000 A GeV.

Certain features of the transport results differ from those based on the corresponding vacuum properties. In particular, it appears that the medium-modified treatment of dispersion relations and partial Δ widths leads to a lowering of the effective temperature of the transverse pion spectra (see fig. 1). Our results suggest that at the quantitative level it is important to take account of these in-medium effects.

[1] J. Helgesson and J. Randrup, Annals of Physics 244 (1996) 12.